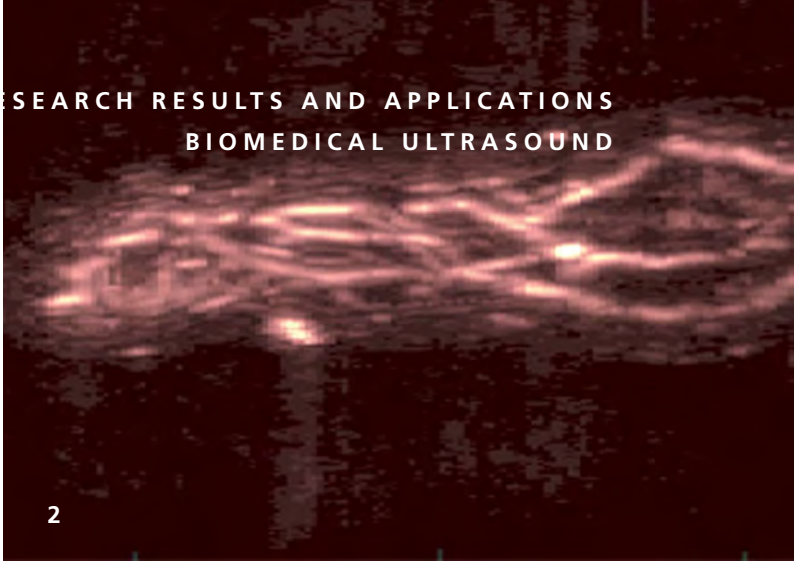
1



2

PROJECT EXAMPLE: IACOBUS – COMBINATION OF ULTRASOUND AND OPTOACOUSTICS FOR ARTHRITIS DIAGNOSIS IN FINGER JOINTS

Background and preliminary work

Arthritis patients often suffer from painful chronic inflammations of the joints. In the advanced stages, these inflammations can spread into the cartilage of the joints or into the bone. In the long term, the disease can lead to a complete rigidity of the joints and thus to dramatic loss of function, for example of the hands. There is no known cure for this disease, but it can be kept at a bay with medication if diagnosed at an early stage. The standard diagnosis procedure is – alongside a blood test – Doppler ultrasound, which is used to detect changes in the blood flow caused by inflammation. The disease can also be diagnosed using X-ray or magnetic resonance tomography. All of the imaging techniques have the disadvantage that they are not very good at detecting arthritis in the early stages.
The Fraunhofer IBMT has been working for some years now on optoacoustic imaging. In this method, ultrasound signals are generated in the tissue by laser light. The combination of optical signal generation and acoustic detection makes special imaging characteristics possible, so that tissue structures can be visualized with acoustic resolution and very high optical contrast. The method is especially suitable for representing blood vessels independently of the limitations of Doppler ultrasound (low resolution, sensitivity to blood flow, user dependency). For this reason, a combined acoustic/optoacoustic imaging system was developed in the IACOBUS project to detect even small vessels arising in joints due to inflammation and thus make a contribution towards early detection of arthritis.

Solution approach

An innovative system especially designed for three-dimensional (opto)accoustic imaging was developed at the Fraunhofer IBMT in cooperation with various European partners. The IACOBUS system is a combined tomography system with which 3D data sets of all finger joints can be recorded in two complementary imaging modalities. While ultrasound is used to investigate unusual bone and cartilage structures (e. g. cartilage deterioration and defects), the optoacoustic element provides highly sensitive imaging of the blood vessels. For this purpose, Fraunhofer IBMT has developed a multi-channel system capable of controlling a tomographic detector with over 700 transmitting and receiving elements. In addition to this, the modules developed by the other partners were integrated at the Fraunhofer IBMT to form a tomography system with fully automated 3D scanning capabilities.

Potential

The technology has already been validated in initial tests, in which the suitability for high sensitivity imaging of the finger vascularization was demonstrated. Due to its automated 3D data acquisition procedure, the high sensitivity of optoacoustics and the absence of typical Doppler artefacts, the IACOBUS system is expected to allow a more objective assessment of vessel growth, especially at the relevant inflamed areas in and around the joint cavity. This is the subject of current investigations, and will soon be validated on patients for the first time. In the long term, this should give clinicians a new way of detecting arthritic disorders at an early stage so that optimum use can be made of the available therapeutic time window.

1 *Combined acoustic/optoacoustic imaging system for finger tomography (Photo: Bernd Müller).*
2 *First optoacoustic 3-D scans of human fingers.*